

determined to have occurred at UE 8; information about the location of UE 8 at the time a RLF is determined to have occurred at UE 8; and information identifying the cell serving UE 8 at the time a RLF is determined to have occurred at UE 8.

[0045] When a connection is next established between UE 8 and the cellular network after a RLF, UE 8 indicates to the cellular network the availability of a RLF report, and sends the RLF report in response to a request from the cellular access network. The availability indication takes the form of a RLF info available indicator in RRCConnectionReestablishmentComplete, RRCConnectionSetupComplete or RRC-ConnectionReconfigurationComplete messages.

[0046] The information contained in the RLF reports received from large numbers of UEs 8 served by the cellular network is used for discovering coverage problems and/or for discovering handover problems and optimising handover parameters, in accordance with the procedures detailed in 3GPP TS 36.300 and 3GPP TS 36.331.

[0047] With the aim of saving power at UE 8, UE 8 may be configured for discontinuous reception (DRX) while in a Connected State. In the absence of any data transmission for UE 8, UE 8 switches off its receiver for a period of time during one DRX cycle before it next checks a control channel for any indication of a data transmission for UE 8. Because UE 8 remains in a Connected state during these intervals, UE 8 does not need to go through the relatively time-consuming process of establishing a new connection with the cellular network in the event that it detects an indication of a data transmission for UE 8.

[0048] The length of the DRX cycle can vary between UEs. For example, with the increasing number of UEs (such as smart phones and laptops) capable of running a wide variety of data applications, and the increasing number of data applications that require seamless delivery and presentation to the user, a long DRX cycle might be used for some UEs to balance such needs for seamless delivery against a desire to reduce power consumption at UE 8.

[0049] As specified at 3GPP TS 36.133 Section 7.6, the radio link monitoring and measurement requirements are relaxed to some extent for a UE 8 in DRX mode operation.

[0050] As described at 3GPP TS 36.213 Section 4.2.1: in DRX mode operation, the physical layer (Layer 1) at UE 8 is configured to, at least once every DRX period, assess the radio link quality evaluated over the evaluation period specified in Table 7.6.2.2.1-1 (copied below) of 3GPP TS 36.133, which can be as high as 12.8 seconds in the case the DRX cycle length is 2.56 seconds.

TABLE 7.6.2.2-1

Q_{out} and Q_{in} Evaluation Period in DRX	
DRX cycle length (s)	$T_{Evaluate_Q_{out_DRX}}$ and $T_{Evaluate_Q_{in_DRX}}$ (s) (DRX cycles)
≤ 0.01	Non-DRX requirements in section 7.6.2.1 are applicable.
$0.01 < \text{DRX cycle} \leq 0.04$	Note (20)
$0.04 < \text{DRX cycle} \leq 0.64$	Note (10)
$0.64 < \text{DRX cycle} \leq 2.56$	Note (5)

Note:

Evaluation period length in time depends on the length of the DRX cycle in use

[0051] When the downlink radio quality estimated over the evaluation period specified in Table 7.6.2.2.1-1 becomes

worse than the threshold Q_{out} , the physical layer (Layer 1) of UE 8 sends an “out-of-sync” indication to the higher layers of UE 8 within the evaluation period. As specified at 3GPP TS 36.133 Section 7.6, the threshold Q_{out} is defined as the level at which the downlink radio link cannot be reliably received and corresponds to 10% block error rate of a hypothetical PDCCH (physical downlink control channel) transmission taking into account PCFICH (Physical Control Format Indicator Channel) errors.

[0052] As specified in 3GPP TS 36.331 Section 5.3.11: upon receiving a pre-specified number of consecutive “out-of-sync” indications from Layer 1 of UE 8, Layer 3 of UE 8 starts timer T310. Timer T310 is not then stopped unless Layer 3 receives a pre-specified number of consecutive “in-sync” indications from Layer 1 while T310 is running, wherein an “in-sync” indication is made when the radio link quality is estimated by Layer 1 over an evaluation period to be better than the threshold Q_{in} , which is defined as the level at which the downlink radio link quality can be significantly more reliably received than at Q_{out} and corresponds to 2% block error rate of a hypothetical PDCCH transmission taking into account PCFICH errors.

[0053] When timer T310 expires, Layer 3 of UE 8 determines that a radio link failure has occurred (STEP 402 of FIG. 4 and STEP 504 of FIG. 5).

[0054] According to one embodiment of the present invention, when a new connection is later established between UE 8 and the cellular network, UE 8 indicates to the cellular network that a RLF report is available, and in a response to a request from the cellular network sends the RLF report to the cellular network, and includes in the RLF report an indication of the DRX cycle length for UE 8 when the RLF was determined to have occurred (STEP 404 of FIG. 4). Alternatively or additionally, UE 8 includes in the RLF report a 1-bit indication of whether or not UE 8 was in a special power saving state (such as that proposed in R2-123160 from 3GPP TSG-RAN WG2 Meeting #78 as an enhancement for diverse data applications (EDDA)) when the RLF was determined to have occurred.

[0055] If the DRX cycle length specified in the RLF report received from UE 8 (STEP 406 of FIG. 4) exceeds a predetermined value, or if the RLF report indicates that UE 8 was in a special power saving state when the RLF was determined to have occurred: then the cellular network determines that the information included in the RLF report is not useful for assessing the performance of the cellular network, and does not use the information contained in the RLF report for that purpose. On the other hand, if the DRX cycle length specified in the RLF report from UE 8 does not exceed the predetermined value, or if the RLF report indicates that UE 8 was not in a special power saving state when the RLF was determined to have occurred: then the cellular network determines that the information included in the RLF report is useful for assessing the performance of the cellular network, and does use the information contained in the RLF report for that purpose (STEP 408).

[0056] According to a second embodiment of the present invention: at the time of configuring the RRC connection for which a RLF later occurred, the cellular network identifies in a RRCConnectionReconfiguration message a DRX cycle length threshold value above which UE 8 should not either indicate the availability of a RLF report to the cellular network, or should not even log the RLF report (which leads to the same result of not indicating the availability of a RLF